

Fish Predation on Pulmonate Limpets

BY

SUSAN BLACKFORD COOK

Department of Zoology, The Ohio State University, Columbus, Ohio 43210

(2 Text figures)

FISHES MAY BE IMPORTANT PREDATORS on invertebrates in tropical marine systems (BAKUS, 1969) either because they inadvertently remove invertebrates while browsing on algae (RANDALL, 1974; VINE, 1974; DAY, 1977) or because they focus specifically on invertebrate prey (HIATT & STRASBURG, 1960). In this note I present indirect evidence that loss of 21% of a population of the intertidal pulmonate limpet *Siphonaria normalis* at Enewetak Island, Enewetak Atoll, Marshall Islands resulted from selective removal by fishes during a spring high tide. Mortality was size-specific and altered the size structure of the population.

Siphonariid limpets occupy specific home sites on rocks (COOK, 1969) when they are not grazing on microscopic algae (VOSS, 1959). Home sites of individuals on soft rocks are marked by "scars," depressions whose dimensions are the same as limpet basal dimensions. Because *Siphonaria normalis* are always "at home" at dead low tide (1 homing failure out of 133 grazing excursions) and limpets which do wander stay close to scars and can be readily recognized by visible gaps between shell margins and the rock, the presence of empty scars at low tide coupled with a lack of "extra" limpets on the rock is evidence of mortality.

Such a combination of events occurred in a *Siphonaria normalis* population located on beachrock on the lagoon side of Enewetak Island. During one late afternoon spring tide (1.5 m above 0 datum, October 6, 1975), four of the 19 original residents of a 25 x 25 cm quadrat disappeared. On the next daytime low tide, I found no "extra" limpets and discovered that empty scars were distinctively marked with grooves extending from the adjacent rock down into scars (Figure 1). Within a nearby 50 x 50 cm area, similar marks were associated with the empty scars of 10 of 49

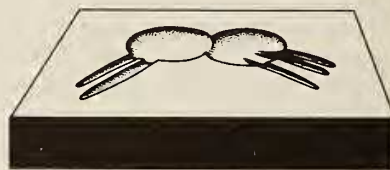


Figure 1

Two adjacent empty limpet scars marked by prominent grooves; each scar is about 8 mm in length

residents, while all of another 50 empty scars on the rock outside of these two areas were marked. Marks were rare on the rock between scars (<10% of the total number found).

Bits of limpet tissue present in two of the marked scars confirmed that limpet mortality had indeed occurred. Although the rock in the vicinity of two additional animals was also marked, these animals escaped removal. All empty scars and marks were obliterated by algal growth within 2-4 days.

Marks were of an appropriate size and spacing to have been made by the canine teeth of a large wrasse such as *Coris aygula* (J. Randall, personal communication). This species is found at Enewetak in shoal areas, as well as deeper water, and often eats mollusks (J. Randall, pers. comm.). Two other possible predators, the golden plover *Pluvialis dominica* (A. Kohn, pers. comm.) and the muricid gastropod *Thais armigera* (Menge, 1973), can be excluded. Plovers are not likely to dive to reach limpets submerged during spring high tides. Predatory snails were not

seen in the area either before or after limpet loss and in any case would not have left grooves on the rock.

Large limpets were clearly more affected than were smaller individuals. The mean length of empty scars (and therefore of former residents) was significantly greater than the mean length of survivors (Figure 2, t-test, $P < 0.001$). Proportions of scars in the size categories 4-7 mm and 8-12 mm were significantly different from proportions expected if limpets had been removed according to initial abundance (chi-square goodness of fit, $P < 0.05$). One reason for the relatively better survival of small individuals may be inaccessibility: the two survivors mentioned earlier were small (<6 mm) individuals whose homes were located at the bottoms of small pits in the rock. Predation resulted in a small but significant decline in the mean length of limpets within the two quadrats (from 6.7 mm to 6.1 mm, t-test, $0.05 > P > 0.02$).

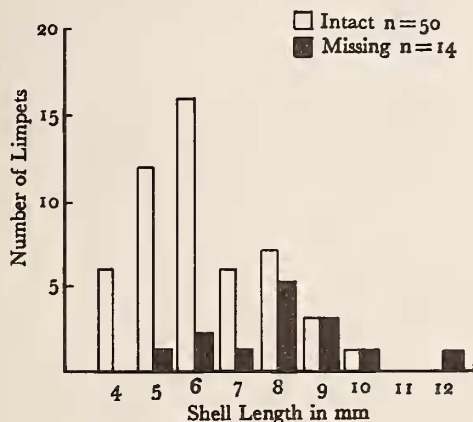


Figure 2

Size comparisons of intact limpets on scars and unoccupied grooved limpet scars following fish predation

Information on how often fish predation affects tropical limpet populations over the long term is lacking. Although such predation is one explanation for the scarcity of large

Siphonaria normalis at Enewetak (less than 1% larger than 8 mm, MENGE, 1973; less than 1% larger than 8 mm at another study site, Cook, unpublished), alternative explanations are possible. These include size-specific predation by *Thais* (MENGE, 1973) or shorebirds, or both, as well as periodic catastrophic mortality of all limpets followed by recruitment and growth of recruits into small to medium sized limpets.

ACKNOWLEDGMENTS

I thank Drs. C. B. Cook and R. A. Stein for editorial comment and Dr. J. Randall for valuable advice on fishes. This work was made possible by a grant from the Energy Research and Development Administration to the University of Hawaii and the Mid-Pacific Marine Laboratory and the Irma E. Voigt Fellowship from the American Association of University Women. This note is a Contribution from the Mid-Pacific Marine Laboratory.

Literature Cited

- BAKUS, GERALD JOSEPH
1969. Energetics and feeding in shallow marine waters. *In: Intern. Rev. Gen. & Experim. Zool.* 4: 275-369
- COOE, SUSAN BLACKFORD
1969. Experiments on homing in the limpet *Siphonaria normalis*. *Anim. Behav.* 17: 679-682
- DAY, R. W.
1977. Two contrasting effects of predation on species richness in coral reef habitats. *Mar. Biol.* 44: 1-5
- HIATT, R. W. & D. W. STRASBURG
1960. Ecological relationships of the fish fauna on coral reefs of the Marshall Islands. *Ecol. Monogr.* 30: 65-127
- MENGE, BRUCE A.
1973. Effect of predation and environmental patchiness on the body size of a tropical pulmonate limpet. *The Veliger* 16 (1): 87-92; 1 pl.; 3 text figs. (1 July 1973)
- RANDALL, JOHN E.
1974. The effects of fishes on coral reefs. *In: Proc. Second Intern. Coral Reef Sympos.* 1: 159-166
- VINE, P. J.
1974. Effects of algal grazing and aggressive behavior of fishes *Pomacentrus lividus* and *Acanthurus sohal* on coral reef ecology. *Mar. Biol.* 24: 131-136
- VOSS, NANCY A.
1959. Studies on the pulmonate gastropod *Siphonaria pectinata* (Linnaeus) from the southeast coast of Florida. *Bull. Mar. Sci. Gulf Caribb.* 9: 84-99

